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Space Science Board Summer Study 1974

Planetary Mission Summaries: Introduction and Overview

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California 91103

August, 1974

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Foreword

This volume series is a collection of planetary mission definitions. They summarize what is now known about several future missions of current interest in NASA planning. Since the missions are at various stages in the planning process, the firmness and validity of the information vary. The level of detail presented, however, is uniformly concise and reflects our present best estimate of the likely characteristics of each mission. Most of the information comes from JPL technical studies sponsored by NASA.

For each mission studied, a baseline concept is defined. The choice of baseline reflects our initial judgment as to what level of performance gives a viable combination of scientific potential, development schedule, and cost. Variations from the baseline, such as launching in a later year or using a smaller or larger spacecraft, are included where they have been studied. Our objective has been to compile in brief form the main technical conclusions of recent mission studies in order that these results may interact with the broader questions of scope, pace, and priorities in the planetary exploration program as a whole.

The mission definitions presented in this series are:

Mars Polar Orbiter (Vol. 2)
Mars Surface Sample Return (Vol. 3)
Mars Rover (Vol. 4)
Mariner Jupiter/Uranus 1979 with Uranus Entry Probe (Vol. 5)
Mariner Jupiter Orbiter (Vol. 6)
Mariner Mercury Orbiter 1978 (Vol. 7)
Early Mariner Comet Flyby (Vol. 8)
Solar-Electric Encke Slow Flyby 1979 (Vol. 9)
Mariner Encke Ballistic Flyby 1980 (Vol. 10)
Solar-Electric Encke Rendezvous 1981 (Vol. 11)
Venus Orbital Imaging Radar (Vol. 12)
Solar-Electric Out-of-the-Eliptic Probe 1979 (Vol. 13)

W. H. Pickering
Director, Jet Propulsion Laboratory

Preface

The purpose of this series of 13 short volumes is to provide future mission information to the 1974 Summer Study Committee for Planetary and Lunar Exploration of the Space Science Board, National Academy of Sciences. We hope that this material will facilitate interactive planning between the definition of scientific objectives and mission design.

Using current study results together with applicable reports and other documents as sources, a set of concise, standardized mission summaries has been prepared. We have grouped the missions by planetary targets, beginning with Mars. The time period covered runs to the mid-1980's.

We summarize each of the 12 missions presented in a separate volume. The scientific rationale, objectives, and typical instrument payloads are described first, followed by a summary of the mission sequence and a brief, illustrated description of the spacecraft. Mission options revealed by the work to date are also considered. Finally, a preliminary analysis is given of funding requirements for the baseline mission described.

This overview volume presents one-page tabular synopses of all twelve missions (reprinted from the individual mission volumes), with the approved Mariner Jupiter/Saturn 1977 mission added for comparison.

We should note that the launch opportunity phasing for many and the cost time phasing for most of the missions studied contain flexibilities, not all of which have been investigated. Furthermore, the funding estimates should be considered only in the context of the stated assumptions and the level of study identified.

The mission studies were performed by and for the Jet Propulsion Laboratory, California Institute of Technology, under Contract No. NAS 7-100, sponsored by the National Aeronautics and Space Administration.

Jesse W. Moore
Advanced Technical Studies Office

Mariner Jupiter/Saturn 1977 Project

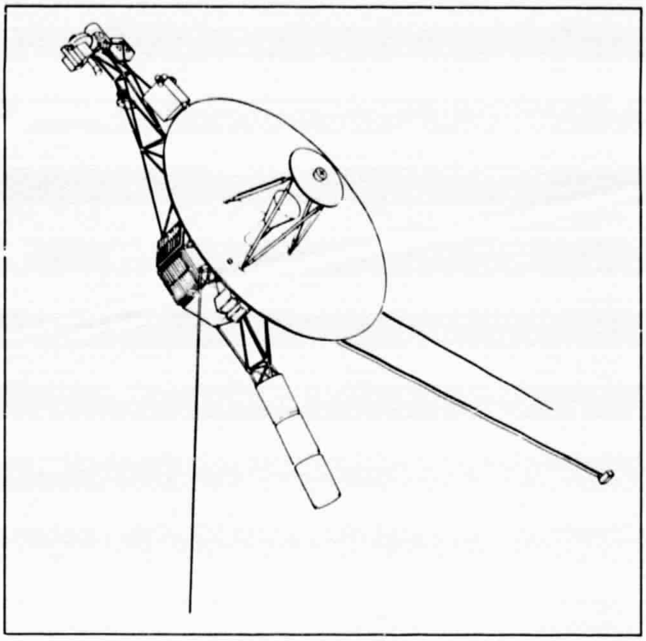
Launch Date: August/September 1977

Encounter Date(s): Jupiter: 1979
Saturn: 1980-81

Injected Mass: (Mission Module) 750 kg

Instrument Mass: 90 kg

Launch Vehicle: Titan III-E/Centaur/MJS propulsion module two launches



Objectives:

To extend the exploration of the solar system to the neighborhoods of Jupiter and Saturn with a spacecraft that can conduct significant scientific experiments at both planetary systems. To conduct comparative studies of the Jupiter and Saturn systems. To perform investigations in the interplanetary and interstellar media.

Science Investigations:

Radio science
Infrared radiation
Imaging science
Photopolarimetry
Ultraviolet spectrometry
Cosmic-ray particles
Low-energy charged particles
Magnetic fields
Plasma particles
Planetary radio astronomy
Plasma waves

Mission Description:

Each spacecraft flies by Jupiter, receives a gravity assist, then flies by Saturn, eventually escaping the solar system. Some satellites of each planet are investigated at various closest-approach ranges. Occultations are performed of each planet, of Saturn's rings, and of satellites where possible; *in situ* as well as scanning experiments are performed. The encounter period for each spacecraft at each planet is about 80 days. The spacecraft design is an RTG-powered Mariner-type with scan platform and encounter data rates of 117 kbits/sec at Jupiter and 45 kbits/sec at Saturn. Measurements of the interstellar media will continue during solar-system escape.

Status:

Project authorized; project started in FY72. The mission design and spacecraft system design phase is presently in progress and will be completed in October 1974. Major procurements are in process for the spacecraft subsystem. Some Viking add-on procurements are presently being delivered. Considerable effort has been committed to development of flight science instrumentation.

Estimated Funding:

(1) Launch vehicle and DSN-support funding excluded.

(2) Inflated dollars equal 5% annual inflation.

Fiscal year	72	73	74	75	76	77	78	79	80	81	Total
FY75 dollars (millions)	7.5	8.5	28.8	73.0	76.4	45.1	17.0	12.8	8.8	13.3	291.2
Inflated dollars (millions)	6.5	7.7	27.4	73.0	80.2	49.7	19.7	15.6	11.3	17.9	309.0

Mars Polar Orbiter

Launch Date: November 1979

Orbit Insertion: September 1980

Orbital Lifetime: 1 Martian year

Injected Mass: 2388 kg

Orbited Mass: 982 kg

Instrument Mass: 100 kg

Launch Vehicle: Titan III-E/Centaur, one launch

Objectives:

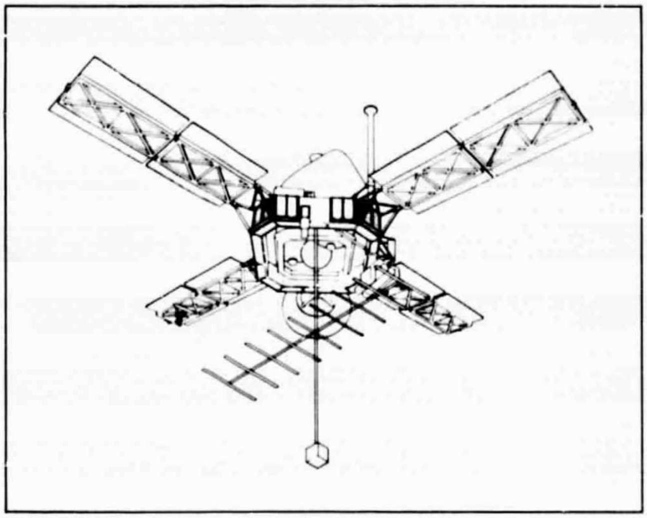
To survey geochemistry of Mars. To map elevation and roughness of surface. To make detailed geological studies. To make climatological investigations including determination of polar glacier composition and dust-storm mechanisms. Gravitational field determination. Reconnaissance of sites for future landings.

Typical Science Investigations:

Gamma-ray spectrometer
Radar altimeter/sounder
High-resolution imaging system
Infrared sounder/water vapor detector
Synoptic imaging system
S- and X-band occultations
Gravity field (radio tracking)

Mission Description:

A single Viking Orbiter spacecraft (VO'75 PTO hardware with minor modifications) is injected into a circular polar orbit about Mars after a Type II transfer from Earth. The altitude is 1000 km, inclination 95 deg; the orbit is Sun-synchronous. Operations are programmed in a simplified, standard mode to minimize cost. X-band telemetry is used to increase data return. A two-year orbital mission is planned.



Status:

Preliminary mission design studies currently underway. Polar orbiter mission also feasible for 1981 Mars opportunity.

Estimated Funding:

(1) Launch vehicle and DSN-support funding excluded.

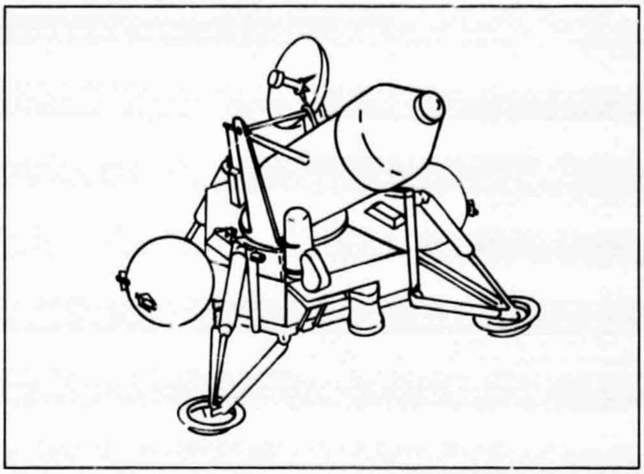
(2) Assumes Viking Orbiter 1975 PTO hardware available; $9–12 million (FY75 dollars) required for new Viking hardware build, if necessary.

(3) Inflated dollars equal 5% annual inflation.

Fiscal year	77	78	79	80	81	82	83	Total
FY75 dollars (millions)	2.4	23.0	52.6	21.5	22.8	8.0	3.3	133.6
Inflated dollars (millions)	2.7	26.6	63.9	27.4	30.6	11.3	4.9	167.4

Mars Surface Sample Return

Launch Date:	January 1984
Mars Arrival:	October 1984
Mars Departure:	December 1985
Earth Arrival:	October 1986
Injected Mass:	4928 kg
Instrument Mass:	35 kg
Returned Sample Mass:	1 kg
Launch Vehicle:	Shuttle/IUS, two launches



Objectives:

To return to Earth selected samples of the Martian surface for in-depth investigations and analyses.

Typical Science Investigations:

Under the baseline mission, the science is confined to acquisition, processing, handling, and return to Earth of sample. Lander facsimile camera is included to document sample. Sample pressure and temperature are monitored during return. Additional science investigations on orbiter and/or lander are under study.

Mission Description:

The mission spacecraft system has five major elements: a lander-delivery-spacecraft/orbiter, a lander, a Mars-ascent system, and an Earth-return vehicle with an Earth-entry capsule. The orbiter and Earth-return vehicle are placed in Mars orbit. The lander acquires a sample and stows it in a canister in the ascent system about 12 days after landing; the ascent system is launched, and, after docking with the Earth-return vehicle, the sample is transferred to the entry capsule. After more than 400 days in Mars orbit, the flight of the Earth-return vehicle is initiated. Near Earth, the capsule separates; after direct entry, the sample canister is recovered. Mariner, Viking, and Pioneer designs are utilized extensively to implement this 1000-day mission.

Status:

Conceptual mission feasibility established; automated rendezvous and docking at Mars can be achieved. Pre-Phase A mission design studies underway. NASA Mars Sample Return Workshop held June 1974. Sampling strategies, back contamination control, Earth recovery and quarantine procedures, and postflight sample analyses requirements have not been considered in JPL studies to date.

Estimated Funding:

(1) Launch vehicle and DSN-support funding excluded.

(2) $25 million (FY75 dollars) included for additional orbiter and/or lander science.

(3) $100 million (FY75 dollars) included for postflight sample analyses and support facility costs, per NASA/SL guidelines.

(4) Mars sterilization costs included.

(5) Earth recovery operations costs excluded.

(6) Spacecraft back contamination control costs excluded.

(7) Inflated dollars equal 5% annual inflation.

Fiscal year	80	81	82	83	84	85	86	87	88	Total
FY75 dollars (millions)	35.0	105.0	250.0	265.0	160.0	55.0	50.0	30.0	25.0	975.0
Inflated dollars (millions)	44.7	140.7	351.8	391.5	248.0	89.5	85.5	53.0	46.2	1450.9

Mars Rover

Launch Date: January 1984

Landing Date: October 1984

Surface Lifetime: 12–18 months

Injected Mass: 4000 kg

Rover Mass: 550 kg

Instrument Mass: 70 kg

Launch Vehicle: Shuttle/IUS, one launch

Objectives:

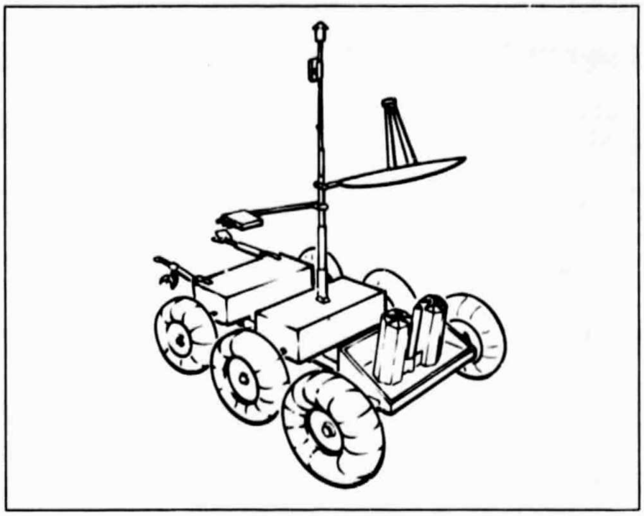
To characterize surface geomorphology, chemistry, volatiles content, and environments for life. To aid in extending the point data of stationary landers and the survey data of orbiters to a statistically meaningful determination of Martian surface properties.

Typical Science Investigations:

Panoramic and closeup imaging
Chemical composition measurement
Mineralogy of soils and rocks
Traverse geophysics
Volatiles measurement
Organics and life detection (optional, not included in baseline)

Mission Description:

Rover, landed by Viking-type descent systems, travels slowly for several hundred km in about a year, with many stops for imaging and other measurements. Ground command is used to revise path, select experiments, and update stored programs to make the missions as adaptive as possible subject to rover constraints. Actual range traversed will be dependent on the science operations implemented along the traverse and on the terrain characteristics encountered by the vehicle. Rover will be capable of negotiating obstacles on the scale of 1 meter.



Status:

Conceptual mission and vehicle studies completed. No study effort currently underway.

Estimated Funding:

(1) Launch vehicle and DSN-support funding excluded.

(2) Long lead time for rover development model testing.

(3) Inflated dollars equal 5% annual inflation.

Fiscal year	79	80	81	82	83	84	85	86	87	Total
FY75 dollars (millions)	16.4	71.5	110.0	143.0	99.0	66.0	22.0	16.6	5.5	550.0
Inflated dollars (millions)	19.4	91.0	147.1	200.7	145.9	102.1	35.7	28.3	9.9	780.1

Mariner Jupiter/Uranus 1979 with Uranus Entry Probe

Launch Date: October 1979

Jupiter Arrival: July 1981

Uranus Arrival: November 1986

Probe Entry Lifetime: Up to 80 minutes

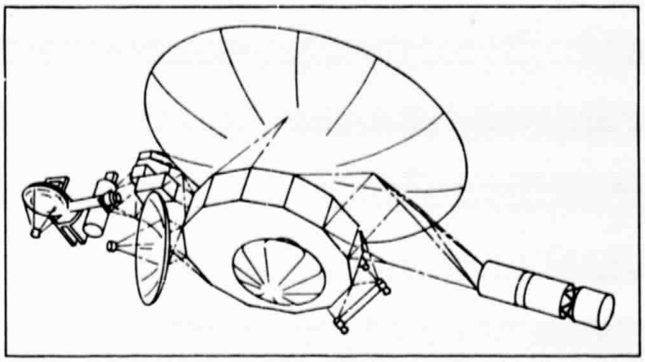
Injected Mass: 825 kg

Flyby Instrument Mass: 52 kg

Probe Mass: 103 kg

Probe Instrument Mass: 13 kg

Launch Vehicle: Titan III-E/Centaur/MJS propulsion module, two launches



Objectives:

To conduct exploratory investigations of Uranus and its satellites. To conduct *in situ* investigation of Uranus, its atmosphere and composition, with deployment of probe to 10 bars or more. To explore the interplanetary medium between the Earth and Uranus and beyond.

Typical Science Investigations:

Flyby: Visual and near-IR imaging
IR radiometer/visual photometer
UV spectrometer
Magnetometer
Plasma probe
Plasma wave
Energetic particles
Radio science

Probe: Accelerometer
Temperature
Pressure
Neutral mass spectrometer
Solar radiometer
Physical properties (H/He)

Mission Description:

Following a Jupiter gravity assist at approximately 12 R_J, the spacecraft approaches Uranus along its axis, viewing the northern hemispheres of planet and satellites. After deploying an atmospheric entry probe, each spacecraft makes a close Uranus flyby (Miranda flyby also possible). Probes will return entry data via flyby spacecraft for up to 80 minutes. The spacecraft design is a direct adaptation of MJS'77. Science measurements at Jupiter are currently under study; measurements of the interstellar media beyond 20 AU will continue as the spacecraft escape the solar system.

Status:

Science rationale developed by MJU Science Advisory Committee. Pre-project mission study underway at JPL; probe design study underway at Ames Research Center. Outer Planet Probe Technology Workshop held at Ames in May 1974.

Estimated Funding:

(1) Launch vehicle and DSN-support funding excluded.

(2) High commonality with MJS'77 and Pioneer Venus projects.

(3) Two new spacecraft and probes; probe sterilization costs excluded.

(4) Probe system manager: Ames Research Center.

(5) Project schedule: Start, October 1, 1976; launch, October 29, 1979.

(6) Inflated dollars equal 5% annual inflation.

Fiscal year	77	78	79	80	81	82	83	84	85	86	87	Total
FY75 dollars (millions)	24.6	96.0	44.3	17.9	5.8	8.6	5.1	5.1	5.4	10.3	11.4	234.5
Inflated dollars (millions)	27.1	111.3	53.6	22.8	7.8	12.0	7.5	7.9	8.7	17.5	20.3	296.5

Mariner Jupiter Orbiter

Launch Date: December 1981

Orbit Insertion: July–October 1984

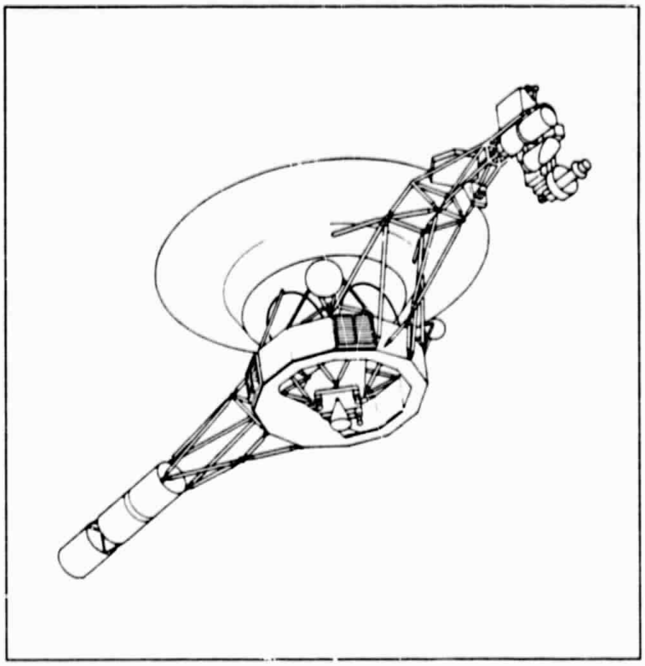
Orbital Lifetime: 30 months

Injected Mass: 1360 kg

Orbited Mass: 675 kg

Instrument Mass: 67 kg

Launch Vehicle: Titan III-E/Centaur/MJS propulsion module or Shuttle/IUS, two launches



Objectives:

To conduct comprehensive exploration of Jupiter and its satellites through long-life, maneuverable, equatorial- and near-polar-orbiting spacecraft. To study the dynamic mechanisms and interactions of the Jovian system both spatially and temporally. This mission will consolidate early Pioneer and Mariner reconnaissance data into a broad structure for understanding Jovian phenomena and processes.

Typical Science Investigations:

Visual and near-IR imaging
IR temperature sounder
UV spectrometer
Magnetometer
Plasma probe
Plasma wave
Energetic particles
Planetary radio astronomy
Radio science

Mission Description:

One orbiter concentrates on satellite survey by multiple close flybys of the Galilean satellites. The second orbiter, in near-polar orbit, concentrates on Jupiter planetology. The irregular satellites are also targets of opportunity. Extensive orbit control is available to both orbiters using satellite gravity assist. Data transmission rates of 120 kbps permit real-time imaging. A new TV sensor provides improved resolution in the near infrared. Up to 85 kg is available for science instrumentation. Mission flexibility provides a wide range of science potential. The spacecraft design is a direct derivative of MJS'77, with Viking-class earth-storable orbit-insertion propulsion.

Status:

Pre-Phase A mission studies currently underway. Formation of science advisory committee and Phase A study planned for FY75.

Estimated Funding:

(1) Launch vehicle and DSN-support funding excluded.

(2) High commonality with MJS'77.

(3) Inflated dollars equal 5% annual inflation.

Fiscal year	79	80	81	82	83	84	85	86	87	Total
FY75 dollars (millions)	27.0	98.0	78.0	36.0	6.0	12.0	29.0	24.0	17.0	327.0
Inflated dollars (millions)	32.7	124.5	103.7	50.4	8.8	18.5	47.0	40.8	30.4	456.8

Mariner Mercury Orbiter 1978

Launch Date: July 1978
Orbit Insertion: May 1980
Orbital Lifetime: 4 months
Injected Mass: 3120 kg
Orbited Mass: 775 kg
Instrument Mass: 68.4 kg
Launch Vehicle: Titan III-E/Centaur, one launch

Objectives:

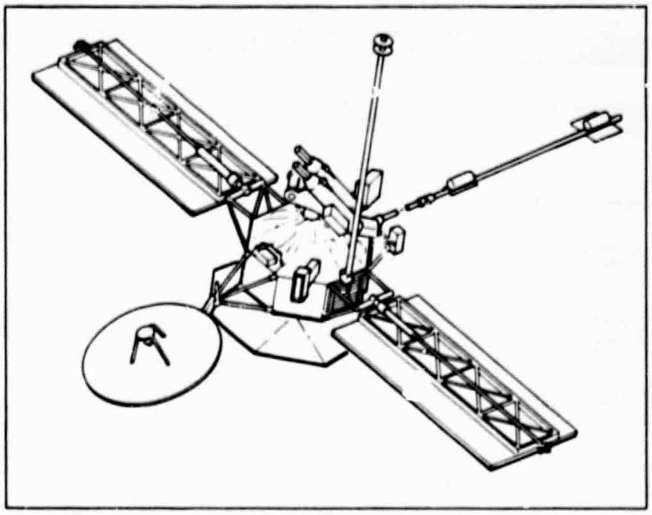
To map Mercury's surface to the order of 500-m resolution. To make extensive measurements of the magnetospheric environment over one hermian year. To test the theory of gravitation in three ways. To determine Mercury's mass distribution. To determine the abundance of radioactive nuclides on surface for composition studies.

Typical Science Investigations:

Imaging (2 cameras)
Magnetometers (2)
Ultraviolet airglow (14-channel)
Charged particle telescope
Plasma science (electrostatic electron and proton analyzer and electron spectrometer)
Infrared radiometer
Theory of gravitation/celestial mechanics
Gamma-ray spectrometer

Mission Description:

Following two Venus swingbys, the spacecraft is inserted into a 24-hour elliptical orbit, inclined 70 deg, with northern-hemisphere periapsis at 500-km altitude. The planet's surface, gravitational field, and magnetosphere will be fully mapped during the approximately 118 days of orbital mapping operations, allowing for a 30-day solar conjunction period of communications loss. The Sun's quadrupole moments and its relativistic effect on Mercury's orbit will also be measured. The spacecraft will be the MVM'73 spare (duplicate build also possible).



Status:

Phase A mission design complete.

Estimated Funding:

(1) Launch vehicle and DSN-support funding excluded.

(2) Assumes availability of MVM'73 spacecraft.

(3) Cost increase for rebuild of MVM'73 spacecraft is 10–15% additional (FY75 dollars), assuming appropriate parts availability.

(4) FY76 start required.

(5) All contractual and procurement actions must be completed by July 1, 1976, to permit hardware work to begin immediately; particularly propulsion.

(6) Inflated dollars equal 5% annual inflation.

Fiscal year	76	77	78	79	80	81	Total
FY75 dollars (millions)	3.2	32.5	26.4	13.8	9.1	4.9	89.9
Inflated dollars (millions)	3.4	35.8	30.6	16.8	11.6	6.6	104.8

Early Mariner Comet Flyby

Launch Date: May 1976 (January 1977)[1]

Encounter Date: August 1976 (April 1977)[1]

Injected Mass: 500 kg

Instrument Mass: 77 kg

Launch Vehicle: Atlas/Centaur, one launch

Objectives:

To penetrate the gaseous coma and approach the nucleus to within hundreds of km in order to obtain *in situ* measurements and imaging. This will help to establish comet science models and to determine the hazards of a comet environment to future comet missions to Encke and Halley. Two comet missions which satisfy the requirements of a precursor are d'Arrest 1976 and Grigg–Skjellerup 1977.

Typical Science Investigations:

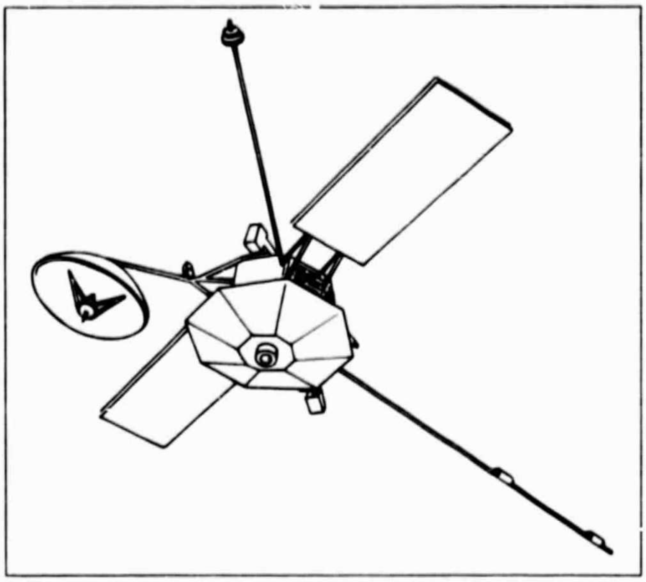
Imaging
UV spectrometry
Plasmas and fields
Mass spectroscopy
Dust detection

Mission Description:

An early and inexpensive comet flyby mission utilizing a flight-proven spacecraft with flight-proven science instrumentation is possible to a faint short-period comet in 1976 or 1977. Comet d'Arrest encounter at a relative velocity of 10.5–12 km/sec can occur from comet perihelion −23 days to perihelion +13 days. Grigg–Skjellerup encounter at a relative velocity of 15–16 km/sec can occur ±10 days from comet perihelion. The spacecraft on either mission will cross the bow shock and penetrate the coma following several days of imaging and UV spectroscopy. Compositional analysis and high-resolution imaging (100-meter resolution at closest approach) will be performed. The MVM'73 spare spacecraft will be used.

Status:

Pre-project mission design completed. Strong science support and early selection of one of these missions are important to the fiscal and scheduling considerations of



a May 1976 d'Arrest or January 1977 Grigg–Skjellerup launch.

Estimated Funding (for d'Arrest only):

(1) Launch vehicle and DSN-support funding excluded.

(2) Assumes MVM'73 spare spacecraft available.

(3) Funding for Grigg–Skjellerup is similar, shifted 7 months with no FY75 dollars required.

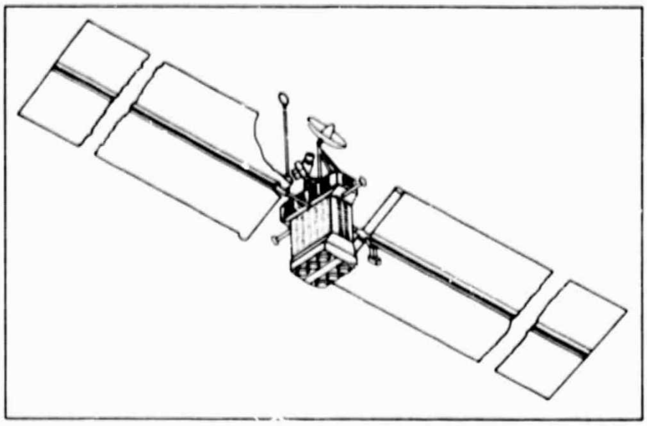
(4) Inflated dollars equal 5% annual inflation.

Fiscal year	75	76	77	Total
FY75 dollars (millions)	5.3	18.4	3.0	26.7
Inflated dollars (millions)	5.3	19.3	3.3	27.9

[1]Dates shown for d'Arrest (Grigg–Skjellerup).

Solar-Electric Encke Slow Flyby 1979

Launch Date:	January 1979
Encounter Date:	November 1980
Injected Mass:	1713 kg
Spacecraft Mass: (Without SEP Module)	430 kg
Instrument Mass:	62 kg
Launch Vehicle:	Titan III-E/Centaur, one launch



Objectives:

To determine the existence and character of the nucleus. To investigate the interaction of the comet and solar plasma. To determine the composition, density, and ionization mechanisms for volatile components. To measure density, size distribution, and motion of dust and ice particles. Demonstration and proof of SEP systems.

Typical Science Investigations:

Imaging
Neutral and ion mass spectrometer
Plasma fields and particles
DC magnetometer
Plasma ion spectrometer
Electric field detector
Low-energy ion and electron probe
Optical dust detector
Hydrogen/deuterium and hydrogen temperature
UV spectrometer

Mission Description:

Solar-electric propulsion provides delivery of a large payload to within 5000 km of comet Encke with relative velocity of 4 km/sec, 30 days before Encke perihelion, at heliocentric distance of 0.75 AU. The mission module is a Mariner-class spacecraft with a scan platform and encounter data rate of 60 kbps. Variations of encounter heliocentric distance, speed, and geometry are available.

Status:

Basic mission and spacecraft design essentially through Phase B. Science rationale developed by NASA Comet and Asteroid Committee.

Estimated Funding:

(1) Launch vehicle and DSN-support funding excluded.

(2) SEP module development assumed funded by NASA/OAST (approximately \$47 million in FY75 dollars). Not included in total below.

(3) Inflated dollars equal 5% annual inflation.

Fiscal year	76	77	78	79	80	81	Total
FY75 dollars (millions)	18.0	42.5	23.4	8.8	4.2	3.8	100.7
Inflated dollars (millions)	18.9	46.8	27.0	10.6	5.3	5.0	113.6

Marine- Encke Ballistic Flyby 1980

Launch Date: August 1980

Encounter Date: November 1980

Injected Mass: 535 kg

Instrument Mass: 74.6 kg

Launch Vehicle: Titan III-E/Centaur, one launch

Objectives:

To determine the existence and character of the nucleus. To obtain first-order measurements on composition of the nucleus, coma, and tail. To map the nucleus to 100-m resolution. To study the comet's interaction with the solar media.

Typical Science Investigations:

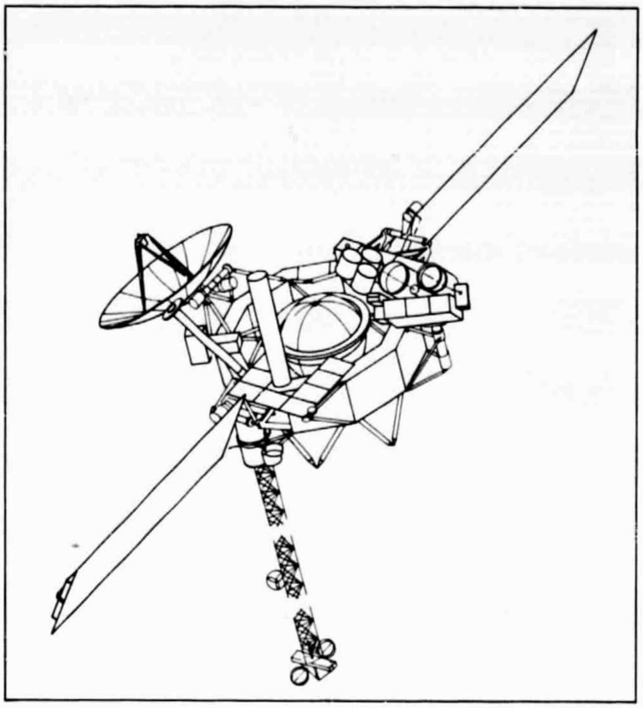
Imaging
UV spectrometer
Pressure modulated (IR) radiometer
Neutral/ion mass spectrometer
Dust analyzer
Optical particle detector
Magnetometer
Plasma wave detector
Plasma probe
Langmuir probe
Micrometeoroid detector

Mission Descriptions:

This mission provides a broad-based fast reconnaissance of comet Encke, building a data base for subsequent more detailed comet investigations, including rendezvous. After a three-month flight, the spacecraft encounters the comet at a nominal range of 700 km. Flyby velocity is 12.1–18 km/sec depending on choice of arrival date (8 to 16 days before Encke perihelion). The spacecraft is of Mariner class, based on MVM'73, VO'75, and MJS'77 designs, with scan platform and 100- to 120-kbps encounter data rate, designed to survive the thermal environment at 0.4 AU.

Status:

Pre-Phase A mission studies underway, including option to encounter at Encke perihelion (at 8 km/sec). Science rationale and payload developed by NASA Comet and Asteroid Committee.



Estimated Funding:

(1) Launch vehicle and DSN-support funding excluded.

(2) Inflated dollars equal 5% annual inflation.

Fiscal year	78	79	80	81	Total
FY75 dollars (millions)	1.3	21.0	47.0	12.0	81.3
Inflated dollars (millions)	1.5	25.5	59.7	16.0	102.7

Solar-Electric Encke Rendezvous 1981

Launch Date: March 1981

Rendezvous Date: February 1984

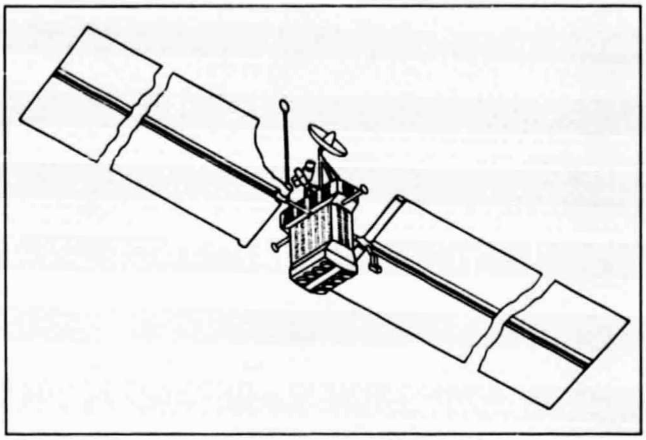
Active Rendezvous Time: ~100 days

Injected Mass: 1980 kg

Spacecraft Mass: (Without SEP Module) 455 kg

Instrument Mass: 90 kg

Launch Vehicle: Titan III-E/Centaur or Shuttle/IUS, one launch



Objectives:

To conduct visual and thermal mapping of the nucleus. To analyze gases and solids flowing from the nucleus. To identify ionization processes occurring near the nucleus. To identify global and surface properties of the nucleus. To investigate temporal variations on cometary processes.

Typical Science Investigations:

Imaging
Neutral and ion mass spectrometer
DC magnetometer
Plasma ion spectrometer
Infrared radiometer
Radar altimeter
Filter wedge spectrometer
Solids analysis package
Optical particle detector

Mission Description:

Three-year solar-electric-propelled flight to an Encke rendezvous at 0.75 AU. Circumnavigation of nucleus and fly-through of coma and tail. Perihelion survival mode with postperihelion observation is planned. The mission module is a Mariner-class spacecraft with scan platform and encounter data rate of 60 kbps.

Status:

Mission feasibility is confirmed by pre-Phase A study of trajectory design and propulsion requirements. Rendezvous sequences and perihelion passage strategies require further analysis.

Estimated Funding:

(1) Launch vehicle and DSN-support funding excluded.

(2) Assumes no SEP precursor mission; funding reduced by $13 million (FY75 dollars) with SEP Out-of-the-Ecliptic Probe 1979. Total includes SEP module costs.

(3) Inflated dollars equal 5% annual inflation.

Encke Rendezvous with No SEP Precursor								
Fiscal year	78	79	80	81	82	83	84	Total
FY75 dollars (millions)	33.2	71.0	40.7	15.1	7.6	8.6	7.6	183.8
Inflated dollars (millions)	37.4	86.3	50.8	20.4	10.7	12.7	11.8	230.1

Encke Rendezvous with SEP/OOE Probe 1979								
Fiscal year	78	79	80	81	82	83	84	Total
FY75 dollars (millions)	32.2	66.0	35.7	13.1	7.6	8.6	7.6	170.8
Inflated dollars (millions)	36.3	80.0	44.6	17.7	10.7	12.7	11.8	213.8

Venus Orbital Imaging Radar

Launch Date: June 1983

Orbit Insertion: October 1983

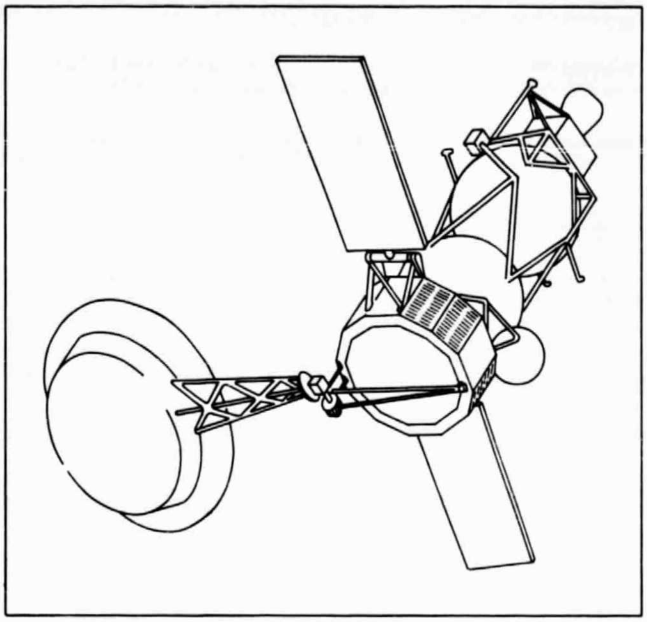
Orbital Lifetime: 120 days

Injected Mass: 3700 kg

Orbited Mass: 675 kg

Instrument Mass: (Radars Only) 47 kg

Launch Vehicle: Shuttle/IUS, two launches



Fiscal year	81	82	83	84	Total
FY75 dollars (millions)	28.0	90.0	81.0	17.0	216.0
Inflated dollars (millions)	37.5	126.6	119.7	26.4	310.2

Objectives:

To image 100% of the surface of Venus at 150-m surface resolution and to image a targetable 5% of the surface at 50-m resolution. Continuous altimetry and approximately 30% stereo overlap at the equator included.

Typical Science Investigations:

Synthetic aperture (side looking) coherent radar to image and map the surface of Venus. Continuous radar altimetry over the whole planet. Additional science investigations under study.

Mission Description:

The spacecraft is inserted into a 97-min, 500-km circular polar orbit. Imaging is done once every eighth orbit. Altimetry and other science are obtained on nonimaging orbits. Five to six orbits of the cycle are used for telemetry and engineering functions. A Mariner-based design with solar power, a tape recorder for data storage, and an advanced earth-storable engine for orbit insertion will be used.

Status:

Pre-Phase A studies have been completed. Technology readiness is planned for a 1981 mission.

Estimated Funding:

(1) Launch vehicle and DSN-support funding excluded.

(2) $25 million (FY75 dollars) included for additional science options.

(3) Inflated dollars equal 5% annual inflation.

Solar-Electric Out-of-the-Ecliptic Probe 1979

Launch Date: June 1979

Encounter: None: Solar orbit with increasing inclination for 36–48 months

Injected Mass: 2625 kg

Spacecraft Mass: (Without SEP Module) 360 kg

Instrument Mass: 31 kg

Launch Vehicle: Titan III-E/Centaur, one launch

Objectives:

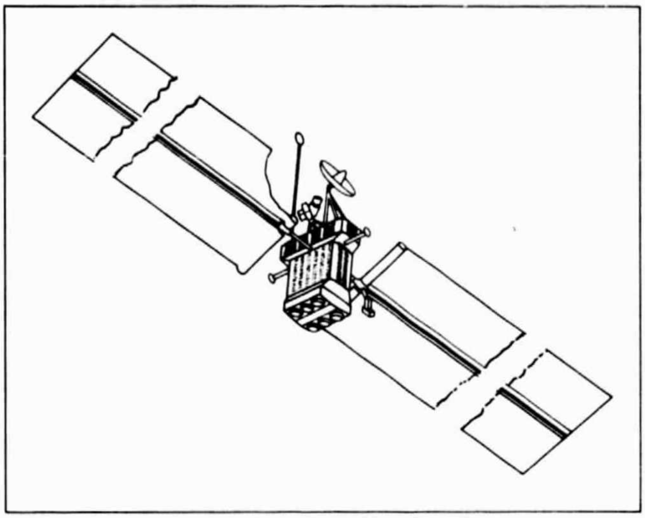
To determine the properties of the solar wind as a function of latitude. To determine the configuration of the interplanetary field and its relation to solar fields. To study the modulations of cosmic rays tc determine the spectrum of intersteller cosmic rays. To observe three-dimensional structure of solar features at radio wavelengths. Demonstration and proof of SEP systems.

Typical Science Investigations:

Helium vector magnetometer
Plasma ion spectrometer
Triaxial electron spectrometer
Plasma wave analyzer
X-ray counter
Cosmic-ray telescope
Zodiacal photometer
Radio emission detector

Mission Description:

Solar electric propulsion used to increase inclination of 1-AU orbit over mission duration. Thrust occurs near nodes of orbital plane and solar equatorial plane with ballistic coast at high latitudes. Inclinations of about 65 deg are achievable. This performance is predicted on thruster lifetimes of 20,000 hours and a spacecraft tailored to the specific requirements of the Out-of-Ecliptic Mission with a 31-kg payload.



An additional objective of observing three-dimensional structure of solar features at optical, extreme UV, and X-ray wavelengths would require the addition of two important instruments, an X-ray/extreme UV spectroheliograph and a coronagraph and would decrease the inclination reached and increase the estimated costs. The mission module is a Mariner-class spacecraft.

Status:

Preliminary mission analysis performed. Spacecraft design is closely related to the Encke Slow Flyby spacecraft which has been extensively studied.

Estimated Funding:

(1) Launch vehicle and DSN-support funding excluded.

(2) SEP module development and flight hardware assumed funded by NASA/OAST (approximately $35 million (FY75 dollars). Not included in total below.

(3) Assumes use of selected Viking Orbiter 1975 and MJS77 spare subsystems.

(4) Inflated dollars equal 5% annual inflation.

Fiscal year	76	77	78	79	80	81	82	83	Total
FY75 dollars (millions)	4.2	17.8	18.1	12.2	5.1	3.1	1.1	0.6	62.2
Inflated dollars (millions)	4.4	19.6	20.9	14.8	6.5	4.1	1.5	0.8	72.6